
RESEARCH DEPARTMENT

# Tonal quality in concert halls

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RESEARCH DEPARTMENT

# TONAL QUALITY IN CONCERT HALLS

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## SUMMARY

A common feature of the design of post-war concert halls is the use of canopies and other surfaces near the platform to reflect sound directly towards the audience. The acoustic characteristics of such halls are contrasted with those of the traditional Leipzig type which were far more suitable for classical music.

Some of the apparent advantages of canopies are shown to be unfounded and it is suggested that such advantages as can be substantiated could be obtained more cheaply and with less serious effect on orchestral quality by building traditionally shaped halls having more seats for the same volume.


## 1. INTRODUCTION

Much has been written about the preferred tonal quality for classical symphonic music and the consensus of opinion seems to be that it should be characterized by that richness which is associated with a reasonably long reverberation time. These conditions are known to occur in old halls in which much ornamentation produces good diffusion of the sound.

On the other hand, the desirable acoustics for small combinations such as quartets and octets are generally assumed to be much less reverberant. With the more modern forms of music, however, such as jazz, dance music and much modern symphonic music, composers appear to desire a much harder* and steelier quality. In the symphony orchestra great use is made of percussion and brass instruments which produce this kind of quality and the modern dance orchestra of course depends largely upon percussion and wind instruments. The tendency to harsh sound is further accentuated in the case of dance music, which is frequently scored for the use of microphones to amplify weak instruments with the result that mechanical and blowing noises, once regarded as unaesthetic, are often audible. The same tendency can be seen even in gramophone recordings of symphonic music, in which close microphones which accentuate scraping and blowing noises are used although attempts are sometimes made to cover this effect by using artificial reverberation. In broadcasting circles the same tendencies are in evidence but they are not employed to such an extent.

*The terms 'hard, harsh, steely, dry, rich, metallic, full' etc. are throughout intended to be descriptive, not pejorative. The available range of tone qualities is generally acknowledged and different qualities may suit different purposes and different individuals.

Much of this hard quality is fostered by the 'high fidelity' market in which the main object often appears to be to accentuate high frequencies. This effect has been variously described as 'music processed with respect to the high frequencies', 'music with a background of escaping steam' and 'high, but not so fi'. It may be that the public appreciates this sort of quality although it is doubtful whether there is much choice since the producer determines the conditions and the public has either to accept or do without.

The position today would therefore seem to be that as far as modern music of all types is concerned, a rather brittle type of quality is desired. Nevertheless, the repertoire of classical music is very great and facilities for its correct performance are essential.

The frequent complaint of musicians and critics after each new concert hall is built is that the tonal quality is unsuitable for symphonic music. This is not surprising since a hard quality is produced by most modern concert halls. There is no doubt that much modern symphonic music, written to produce a strident result, can be performed equally well in an old hall or a modern hall and as far as dance music is concerned there seems to be no reason for special acoustics for this purpose; indeed, some performers prefer reverberant acoustics. If this is a correct assessment it is only for classical music that concert halls are required having a rich tonal quality.

## 2. CHARACTERISTICS OF LEIPZIG TYPE HALLS

It is probably generally agreed[1,2] that the tonal quality of concert halls for classical symphonic music should have traditionally the following characteristics:

1. Reverberation - the sound should be reverberant but not too reverberant otherwise confusion takes place.
2. Blend - the blend of the orchestra should be good so that it appears as a coherent source and not as a collection of musicians, yet it should be possible to hear all the parts clearly even in a tutti.
3. Definition - individual instruments and sections of the orchestra must be clear.
4. Singing Tone - this is the term frequently applied to a tone quality more easily recognized than described.
5. Sound Distribution - should be even throughout the hall.
6. Reinforcement - sound volume should build up easily in crescendi and fortissimi, a feature especially important to strings and woodwinds.
7. The audience should feel that the reverberation comes from all directions.
8. Liveness - the hall should be responsive to performers.
9. Absence of Echoes - i.e. of discrete reflexions.
10. Absence of Resonances audible as 'colourations' - whether due to the structure, or undamped room modes, i.e. acoustic resonances related to the room dimensions.

These characteristics were frequently achieved in the concert halls of the Leipzig type, described as such because they resemble the new Gewandhaus in Leipzig. This hall was rectangular in plan, elevation and section. It had a flat floor and shallow balconies round the sides and the elaborate ornamentation typical of the period. There were several good examples in Britain, but unfortunately they were all destroyed by fire. They were the Colston Hall (Bristol), the Philharmonic Hall (Liverpool), the Free Trade Hall (Manchester) and St Andrews Hall (Glasgow). The first three have been rebuilt in a form which many people consider to be less satisfactory than the original as regards the acoustics and the fourth, destroyed last year, has still not been replaced. This hall is shown in Fig. 1.

## 3. TRANSITION TO THE MODERN HALL

It is interesting to consider when the changes in architectural design of concert halls began to take place. The first landmark was the Salle Pleyel in Paris, which is designed on the theory that sound should be reflected from the performers

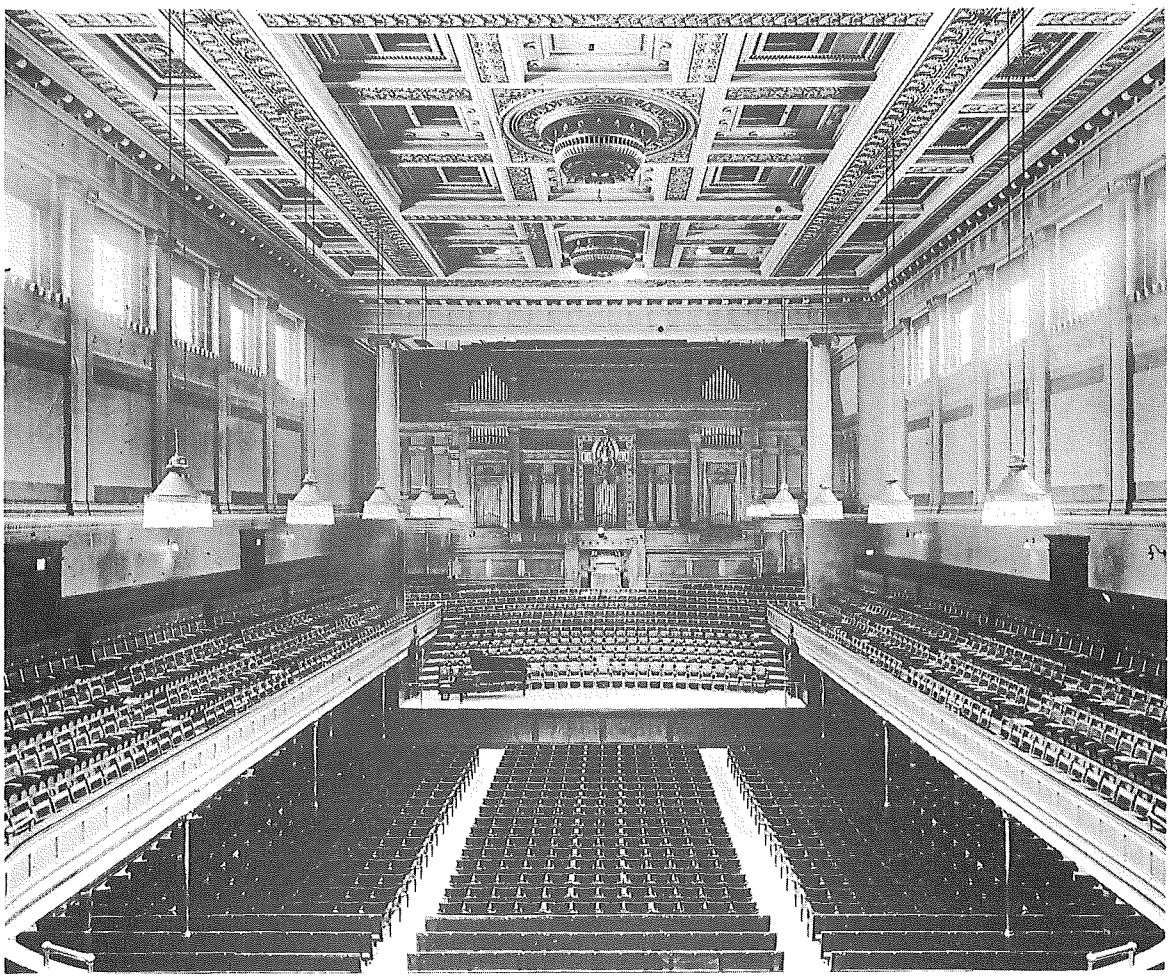

*Fig. 1 - Photograph of St Andrews Hall, Glasgow*

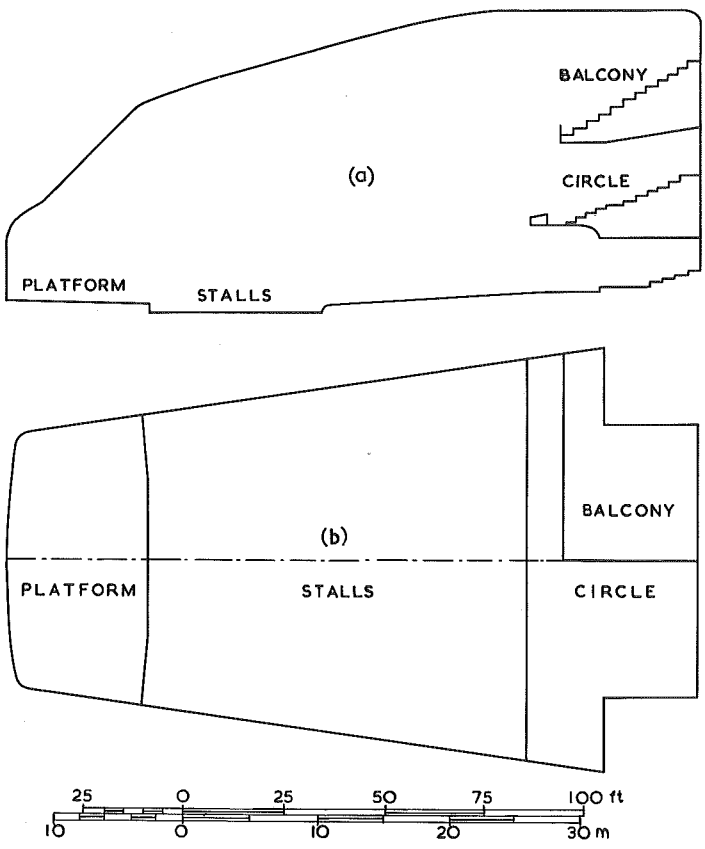


*Fig. 2 - Long Section and Plan of Salle Pleyel*

and directed on to the audience. This hall, shown in Fig. 2, exemplified this theory, the walls and ceiling being so shaped that the sound is projected on to the audience seated in raked stalls and two balconies. In fact the acoustic performance for music in the Salle Pleyel is unsatisfactory and concerts are not usually given there. Nevertheless, the principle of projection of sound seemed to catch the imagination of architects and has been widely adopted in textbooks on acoustics. In most architectural schools the projection of sound is illustrated by elementary optical analogies which are often carried beyond their range of validity and may result in the poor performance of many concert halls.

In Great Britain the Liverpool Philharmonic Hall, which had been destroyed by fire, was rebuilt and opened in 1939. This hall has a fan shape and shaped ceiling and splays. The tonal quality is rather hard and the reverberation time is short (Table 1). The number of seats is 1955, none of them under balconies and conditions are reasonable but not as good as the old hall. The same story has been repeated in the rebuilt Colston Hall and Free Trade Hall. In both of them the reverberation time is shorter than desirable for classical symphonic music and the tonal quality is hard. Definition is poor in loud passages; the blend of the orchestra is not good in the Free Trade Hall although it is reasonable in the Colston Hall. The Colston Hall appears to be better than the other reconstructions although less satisfactory than the original hall.

In addition to the reconstructions just described, the most important new hall in Britain is the Royal Festival Hall, Fig. 3, which is also the largest hall designed for concerts in this country. Although the basic plan is rectangular, this hall is equipped with splays, a reflecting canopy and a ceiling shaped to direct sound on to the audience. A normal reverberation time between 1·8 and 2 seconds was intended in this design, but it is less reverberant than the other new halls mentioned. This may be in part due to the fact that in order to accommodate a large audience, the side walls are provided with boxes which act as a particularly efficient form of absorption, a well-known effect in opera houses. The resulting subjective impression is that the reverberation time is even shorter than the measured reverberation time. This hall has the characteristic deficiencies of recent designs since, in addition to

*TABLE 1*

*Data of ten Concert Halls*

| CONCERT HALL | VOLUME cu ft | NO. OF SEATS | VOLUME PER SEAT cu ft | R.T. SECS WITH AUDIENCE |
|---|---|---|---|---|
| Gewandhaus, Leipzig | 375,000 | 1560 | 240 | 1·55 |
| St Andrews, Glasgow | 569,000 | 2133 | 267 | 1·9 |
| Salle Pleyel, Paris | 800,000 | 3000 | 266 | 1·55 |
| Philharmonic Hall, Liverpool | 479,000 | 1955 | 245 | 1·5 |
| Royal Festival Hall, London | 775,000 | 3000 | 258 | 1·47 |
| Free Trade Hall, Manchester | 545,000 | 2569 | 212 | 1·6 |
| Colston Hall, Bristol | 475,000 | 2180 | 218 | 1·7 |
| Usher Hall, Edinburgh | 565,000 | 2760 | 205 | 1·65 |
| Fairfield Hall, Croydon | 544,000 | 1894 | 288 | 2·0 |
| Philharmonic Hall, New York | 865,000 | 2644 | 327 | 2·1 approx. |

the short reverberation time, the blend is poor and it is not possible to hear all the instruments in tutti. The tonal quality is hard and there is no singing tone.

A recently built concert hall is the Fairfield Hall in Croydon. This is an interesting example of modern design in that although it has a canopy, splays and a deep balcony, the designers have managed to keep the reverberation time up in the region of 2 seconds by providing a large volume per seat of 288 $ft^3$. In this hall there is an area up to two-thirds back in the stalls where the listeners have the impression of being surrounded by the reverberation. Further forward, because of the width of the hall, the listener has the feeling that the orchestra is rather too much extended horizontally and the direct sound

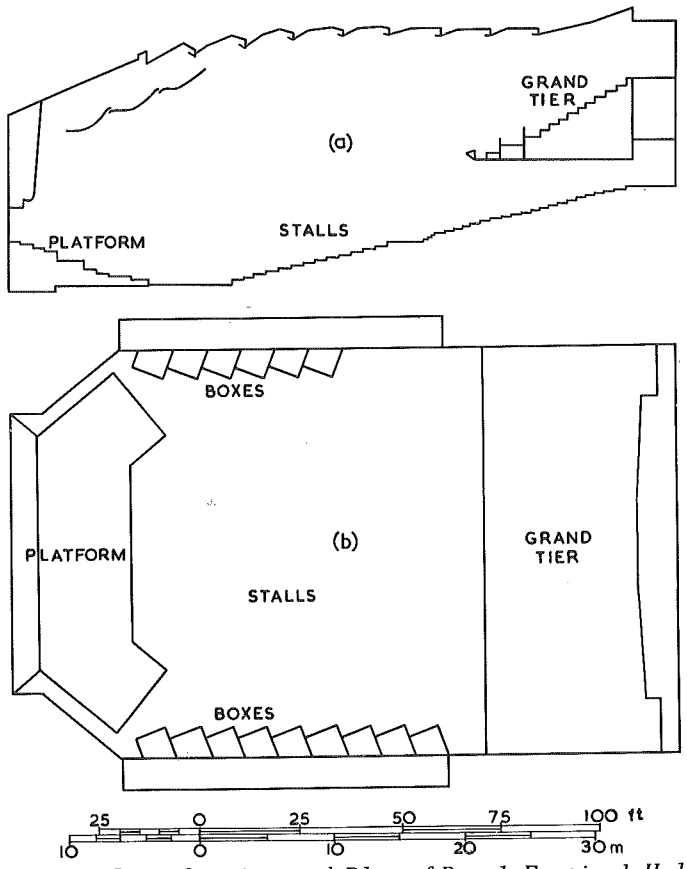


*Fig. 3 - Long Section and Plan of Royal Festival Hall*

predominates. In and under the balcony the reverberation appears to come from the stage. Here again the impression is that the reverberation time sounds shorter than the measurements indicate. This hall is too recent for a consensus of opinion on its acoustic characteristics to be established; in the authors' opinion the tonal quality is acceptable although it could perhaps be best described as 'metallic'. There is no singing tone. In its general characteristics it resembles the Colston Hall.

Another recent design, this time in the U.S.A., is the Philharmonic Hall in New York.[2] In this also the basic design is rectangular with shallow side and back galleries. The acoustic consultant, Dr Beranek, does not employ a canopy but many reflecting panels suspended from the ceiling and adjusted at various angles. This is done to enable some sound to penetrate between the panels to the structural ceiling so that the volume above, on which the reverberation depends, is still acoustically accessible. So far the comments of the critics have not been favourable. The acoustics of this hall have been compared to over-amplified hi-fi[3] and it has been stated that the audience has no feeling of tonal immersion.[4] The authors, however, have no first-hand experience of this hall. It has been announced that adjustments will be made in the summer of 1963.

## 4. CHARACTERISTICS OF MODERN HALLS

The characteristics of modern halls may be listed as follows:

1. Lack of reverberation.
2. Poor orchestral blend; many instruments inaudible in tutti, the sound being dominated by brass, percussion and piccolo.
3. Definition satisfactory.
4. No singing tone.
5. Sound distribution patchy.
6. Reinforcement poor so that crescendi are not impressive.
7. The audience is not 'in the reverberation' which appears to be in the front.
8. Performers find these halls unresponsive.
9. Performers have difficulty hearing each other.
10. In some there are echoes.
11. In many there are resonances.

The situation would seem to be therefore that only on the score of definition are modern halls not criticized.

## 5. DESIGN FEATURES OF NEW HALLS

When the design of new concert halls was considered in the late 1940s, most of the organizations concerned made surveys of new and old halls to obtain data on

which to work. Reverberation measurements were made and the opinions of musicians and music critics sought. The most extensive surveys were carried out in this country by the Building Research Station[5] and the BBC[6] while Kuhl in Germany[7] and Beranek in the United States[2] have more recently surveyed the position.

The Building Research Station carried out its survey in 1947-8. Reverberation measurements were made in all the important concert halls in this country and the opinions of musicians and critics were sought. The result of this investigation showed that the most favoured hall was the Liverpool Philharmonic Hall with the Usher Hall, Edinburgh, second. Definition was considered the most important attribute of a hall, with a 'full' tonal quality secondary. In this context it is easy to understand their choice.

The BBC Research Department carried out experiments with the co-operation of the Hallé Orchestra in which the same piece of music was played in a number of concert halls. In these experiments the same apparatus was used in each hall and the same individuals were concerned in reproducing on the recordings the most realistic sound for the hall concerned. These recordings were assessed by observers who were arbitrarily classified into professional musicians, the general public and broadcasting experts. The last category was the only one giving significantly concordant answers. The preferences of this group were for St Andrews Hall, Glasgow, first and the Usher Hall, Edinburgh, second. It must be admitted, however, that the observers who gave these preferences are a small minority of the population although this criticism can also be levelled against the results obtained by the Building Research Station.

In 1955 W. Kuhl carried out an investigation in which he made recordings of the same music in many halls in Germany. The minimum distance of the microphone from the orchestra in relation to the reverberation time was specified to give a constant direct/reverberant sound ratio, and the recordings were judged by a large number of observers who gave opinions on the most acceptable reverberation. From this Kuhl deduced that for Romantic Period symphonic music a reverberation time of 2·1 seconds was preferred, for modern music 1·5 seconds and for Classical Period music such as Mozart 1·5 seconds. He suggests 1·7 seconds as a compromise. The recordings were carried out by the regional broadcasting organizations so that the equipment was not the same in each location. Furthermore, no attempt was made to produce the most realistic conditions for each concert hall. Each 'Tonmeister' produced what he considered to be the best reproduction as opposed to the most characteristic representation of the hall.

Before the construction of the New York Philharmonic Hall Beranek[2] carried out a very extensive survey of world-famous concert halls and his conclusions are that the most acceptable quality is that obtained in the good Leipzig type of concert hall. Moreover, he appears confident that this can be synthesized in modern halls provided that large numbers of reflecting surfaces are installed and correctly adjusted.

## 6. THEORY OF DESIGNS OF POST-WAR HALLS

One of the most important factors in the new designs is the large number of seats required to ensure an adequate income for symphonic music. Most designers are

agreed that a reverberation time between 1·8 and 2 seconds is necessary and this is related to volume per seat. An unduly large seating area is therefore essential with the consequence that many seats would be too distant from the orchestra. To overcome this difficulty most of the new designs have large balconies. Consequently it is assumed that it is necessary to use reflectors to obtain an adequate sound intensity at the back of this type of hall and under the balconies. It was also considered that such large halls would lack intimacy. This consideration was based upon investigations by Haas (which will be discussed later) which were interpreted to mean that strong first reflexions were desirable to increase the ratio of direct to reverberant sound, and so we find that canopies and reflecting splays are provided to increase intimacy, definition and loudness at the back. They also reflect some sound back to the performers.

### 6.1. Sound Level in Rear Seats

It may appear at first sight self-evident that a large reflector over the orchestra, by directing sound towards the back, will increase the sound level at the rear seat positions. In fact this is not actually so. The authors made measurements some years ago, described in the Proceedings of the I.E.E.,[8] in which microphones were placed behind the conductor and in remote parts of a number of concert halls and recordings were made simultaneously from two or more microphones during the performance. The results of this investigation showed that differences due to direction of sound were negligible. This possibly surprising result is explained by the fact that even under balconies most of the sound energy reaching the rear seats is reverberant, so that as far as loudness is concerned no appreciable gain can be noticed due to the reinforcement of the direct sound by a reflecting canopy. It should be added that the reinforcement of the direct sound with respect to the reverberant sound has the noticeable subjective effect of reducing the apparent reverberation time.

### 6.2. Definition

Immediately after the war an investigation was carried out in Germany by Haas[9] who showed that if listeners were presented with a sound from two loudspeakers, one of which radiated the sound delayed in time by between 10 and 50 milliseconds, the whole sound appears to come from the undelayed loudspeaker even if the level from the delayed loudspeaker is greater by 10 dB. This has proved to be a very useful discovery from the point of view of sound reinforcement systems, since in very large halls loudspeakers have to be placed in such positions that the reinforced sound would reach the audience before the speaker's voice. If a delay is incorporated into the amplifier control, the reinforced sound will appear to come directly from the speaker. It has been assumed, therefore, that reflecting canopies and splays will improve definition in a concert hall because the direct and reflected sound will merge and appear to come only from the instruments.

It has however been observed by the authors that in such cases the sound from the orchestra often comes from a position above the stage instead of directly from the orchestra itself. This is apparently due to the direct and reflected sounds not merging according to the findings of Haas.

Recently some preliminary experiments have been carried out in the BBC Research Laboratories with loudspeakers arranged in the vertical plane to investigate this phenomenon. It has been found that even with quite long delays the image position between two loudspeakers is determined by the difference in loudness and delay and there is no evidence that the undelayed loudspeaker takes precedence in the way postulated by Haas for horizontally arranged loudspeakers. Although the results have yet to be confirmed, they appear to account for what happens in concert halls with canopies. It is of course not surprising that the laws governing directional discrimination in the horizontal and the vertical plane are different since the location of the human ears in a horizontal plane would prima facie appear to make vertical discrimination difficult if not impossible.

Dr Beranek, in his book, suggests the theory that one of the important characteristics of classical designs was the time delay between the direct sound reaching the listener in the middle of the stalls and the first reflexion from the side walls. This he calls the 'initial time delay gap' and from a study of many halls he has concluded that it should not exceed 23 milliseconds. Because of the seating required in the Philharmonic Hall, New York, and the need to adopt the correct volume per seat, the hall is too big to permit the time delay gap to be as short as 23 milliseconds. It is to provide the necessary reflexions that he introduced the suspended reflecting panels.

The initial time delay gap as specified by Beranek may to some extent be unrealistic. Examination of the drawings of a number of halls seems to indicate that in many of them the first reflexion is unlikely to reach the audience on the floor in the way Beranek postulates. Oscillograms of sound decays obtained by the authors in old concert halls do not show a strong first reflexion of this type, probably because the principal reflecting surfaces on the walls are above the level of the orchestra and therefore do not reflect sound back to the floor. It is probable that in these halls the first sound, after the direct sound, to reach the listener in the middle of the stalls is reverberant.

### 6.3. Reflexion to Performers

When sound has been directed away from the orchestra on to the audience and largely absorbed, the performers find it difficult to hear each other and the performance tends to lack cohesion. The canopy over the orchestra is therefore usually designed to reflect part of the sound back to help them.

## 7. BBC EXPERIMENTS WITH REFLECTORS

About fifteen years ago the BBC carried out experiments with reflectors near orchestras, because at that time the acoustic re-adjustment of a large orchestral studio was under consideration. It was found that placing reflectors near orchestras had the effect of producing a hard and unpleasant string quality which was disliked by listeners in the studio. No microphones or loudspeakers were involved in this judgment. Since this appears to be just what is done in modern designs it is therefore not surprising that hard quality is one of the characteristics of most modern concert halls. Moreover, the reflectors were found to produce standing wave effects which were recognized as patchy sound distribution and excessive variation of quality with position.

Recently an interesting experiment on the use of a reflecting canopy was carried out in the Guildhall, Southampton. This became possible as a result of a fire on the stage which made a certain amount of rehabilitation necessary. The opportunity was considered by Southampton Corporation to be suitable for attempting to improve the acoustics. While it was realized that alterations to the stage were not likely to make a very marked difference to the acoustics of the Guildhall, it was thought worthwhile making whatever improvements were possible. As is usual in these cases, thoughts turned first to reflecting canopies but in view of the doubts about this method Southampton Borough Architect decided to carry out experiments with the co-operation of the Bournemouth Symphony Orchestra. The advice of one of the authors was asked and the BBC also took part in the experiment because of its scientific interest.

A temporary reflecting canopy was erected which could be arranged in the normal fashion or raised with the component parts arranged horizontally so that it no longer reflected sound into the hall. This is shown in Fig. 4. In this hall as originally designed there is a horizontally curved reflector on the back wall of the

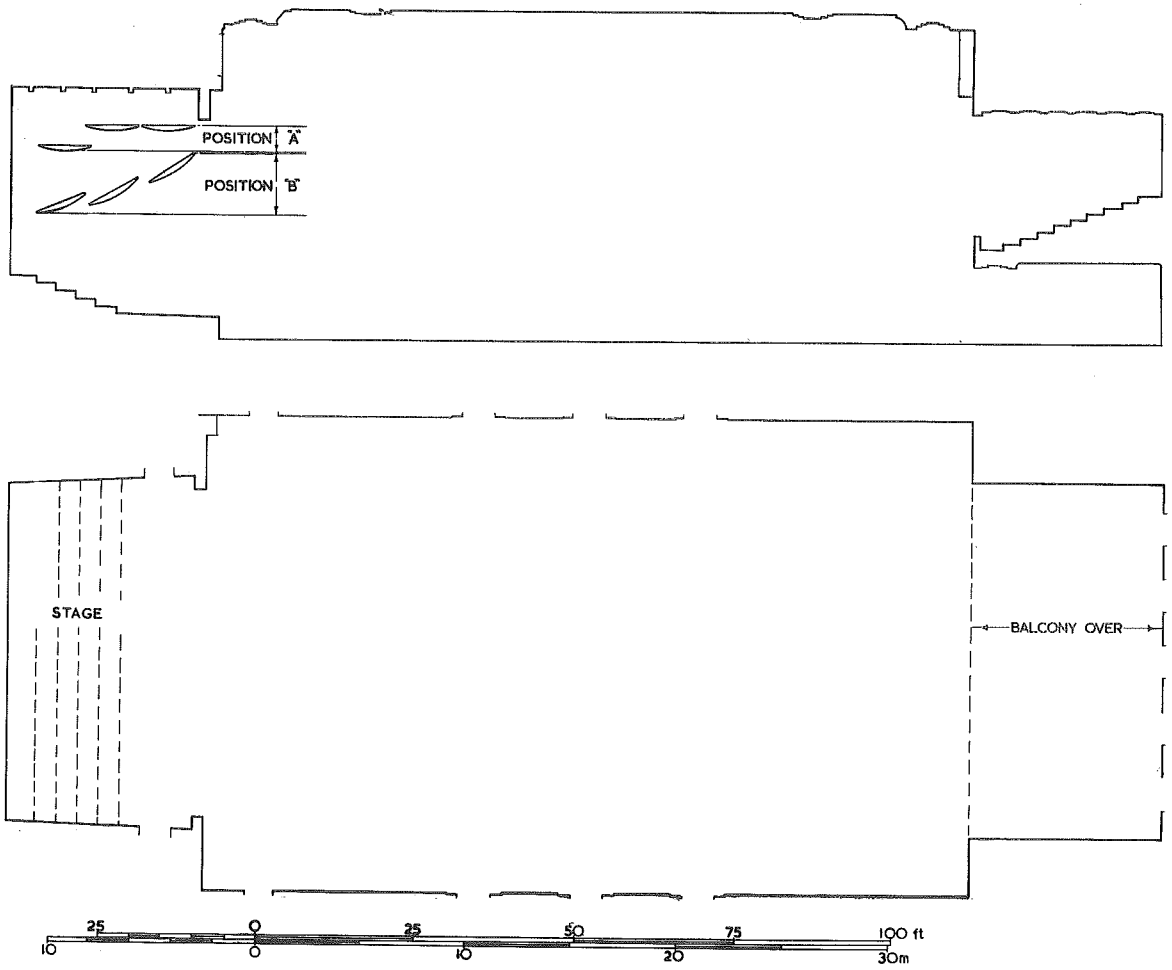


*Fig. 4 - Long Section and Plan of Southampton Guildhall*

stage and so arrangements were made for this to be covered by curtains or uncovered as necessary. Four conditions were tried with the Bournemouth orchestra as follows:

A. Reflecting canopy without curtains on rear reflector.

B. Reflecting canopy with curtains on rear reflector.

C. Reflecting canopy horizontal without curtains on rear reflector.

D. Reflecting canopy horizontal with curtains on rear reflector.

The results of these variations in the hall were observed by listeners whose opinion was that when the reflectors were in full operation the sound had a wiry or hard quality and that the distribution was more patchy than without reflectors. As a result of the investigation it was decided not to fit a reflecting canopy and an alternative treatment, giving mainly diffusion, has been designed.

## 8. DISCUSSION OF ACOUSTICS OF LEIPZIG TYPE HALLS

The characteristics required for classical symphonic music have already been given. Many of the Leipzig type halls provided the correct conditions to give the desired tonal quality and it is therefore worthwhile considering how these effects were achieved even if there were no established design criteria.

The Gewandhaus itself was small by modern standards, seating only 1560 people. The reverberation time was consequently shorter than that of other halls of similar design such as St Andrews, Glasgow. A reverberation time of 1·8 to 2 seconds is more usual, with a volume per seat of at least 260 $ft^3$.[1] The floor was usually flat and there were shallow balconies with considerable space above for the sound to reverberate. In these halls the decay of sound at any frequency is smooth and from experience of broadcasting this seems undoubtedly to be due to the good diffusion of sound obtained in the old halls by the elaborate ornamentation. The most important surface producing good diffusion appears to be the ceiling since the walls, although ornamented, had only shallow modelling. In these halls, principally because of the good diffusion, the orchestra is well blended and all the instruments can be heard clearly throughout the enclosure. Furthermore the reverberant sound appears to come from all directions to the audience. In some of the old halls the only obvious means except diffusion whereby the performers can hear each other is by reflexion from two parallel surfaces on either side of the stage. These surfaces are not great in area and have no noticeable effect upon the general acoustics. Confirmation of this has been obtained in a number of broadcasting studios by providing such surfaces to help the performers hear each other. In the old halls echoes were kept under control because of the irregularity in the interior decoration which eliminated large reflecting areas. Moreover, the method of construction, using timber, lath and plaster, ensured that there were no obvious resonances and that any which existed were well distributed throughout the low frequency region. It would seem that singing tone only appears in halls in which the diffusion is good, the reverberation time is long and the decays are smooth.

Investigations in all types of concert hall lead to the conclusion that the Leipzig type of hall is generally satisfactory for symphonic music. The modern halls all have to some extent faults which are similar to those caused by lack of

reverberation. Concert halls without reflectors also exist which are insufficiently reverberant and in these the faults enumerated in new halls can be found. The sound is hard; there is difficulty in hearing all the parts when the full orchestra is playing loudly. A good example of surroundings in which the reverberation time is short is the opera house. In a well designed opera house, such as Covent Garden, the tonal quality is dry, but the faults associated with direction of sound in concert halls are absent. Nevertheless in these opera houses diffusion is good and consequently definition and blend are satisfactory. It is of interest that in many positions in opera houses there is little or no direct sound from the orchestra.

It therefore might be argued that if the type of tonal quality provided in most modern halls is really desired, a very similar effect could be obtained by designing concert halls with less reverberation. The easiest way to ensure a short reverberation time is to decrease the volume for the same seating capacity. If a volume not greater than 200 $ft^3$ per person were adopted as in opera houses and good diffusion were ensured, a hall could be designed with similar characteristics to the modern halls but with the advantage that the patchy sound distribution caused by reflectors would be absent. The other great advantage of this procedure would be reduced cost. We need hardly say that we are not in favour of this approach but if the musical profession is satisfied with modern halls this might be a logical architectural solution.

In the near future there may be a need to make a decision on the type of acoustics desired in concert halls since St Andrews Hall, Glasgow, will have to be replaced. It is to be hoped that the decision will be in favour of a Leipzig type which will have the musical characteristics of its predecessor.

## 9. CONCLUSIONS

The tonal quality of the modern concert hall is a direct result of the basic concept of the design. The need for large audiences has resulted in deep balconies so that architects have generally considered reflectors to be essential to increase the ratio of direct to reverberant sound. Beranek has also introduced the concept of initial time delay gap and on this basis he argues that numerous reflectors are required. It appears however that the projection of sound on to the audience causes efficient absorption of the direct sound so that there is less energy available for reverberation. The performance of all modern halls confirms this since in most of them the reverberation time is much shorter than desirable and is accompanied by the curious effect that they appear to be less reverberant subjectively than the measured reverberation time would indicate. The resultant tonal quality is very similar to that obtained in non-reverberant surroundings. This is confirmed in concert halls which are noted for their lack of reverberation, in which there is hard quality, poor orchestral blend and lack of singing tone. Moreover, the observed effect of canopies and reflectors, if they are at all effective, is the production of standing wave conditions resulting in interference effects varying with frequency throughout the hall.

It is therefore suggested that in the modern concert hall which has been provided with a volume per seat sufficient to ensure adequate reverberation, the reverberation is reduced by the direction of sound on to the audience. If a volume

per seat of the order of that common in opera houses, not greater than 200 $ft^3$ per person, were adopted and good diffusion were also ensured, the resultant reverberation time would be of the same order as in many modern concert halls. Although the end result would be poor tonal quality, two advantages would accrue, a more uniform sound distribution and a considerable saving in cost.

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# Is Clarity All We Want From Our Concert Halls?

The photograph of Berlin's new Philharmonic Hall that appeared in Wednesday's issue of *The Times* was impressive enough, but still more impressive was our correspondent's assurance that, with a few reservations, its acoustics are excellent. If this is so (and it is widely confirmed by independent sources) then Professor Scharoun has produced the first concert-hall for some time to fulfil its primary function straight away.

It seems odd that our technological age should find it so difficult to produce a satisfactory concert-hall, but some of the reasons have been suggested recently in an article by two members of the B.B.C. Research Department, T. Somerville and C. L. S. Gilford, that appeared in last month's *Musical Times* —an article whose conclusions are sufficiently important to be worth recapitulating. They are, briefly, that the older style of hall (we may call it the Gewandhaus type, after the famous Leipzig hall built in 1844 and destroyed in the last war)—rectangular in plan, elevation and section, and with a shallow balcony round three sides —produced better acoustic results than any of the more modern types which make use of directionally reflected sound.

## OLD HALLS DESTROYED

This is particularly important because with the burning of St. Andrew's Hall, Glasgow, just a year ago tomorrow, all the best examples of the Gewandhaus type in this country have disappeared. Most of these, such as Bristol's Colston Hall, the Philharmonic Hall at Liverpool and the Free Trade Hall in Manchester, have now been rebuilt in a form, to quote Messrs. Somerville and Gilford, "which many people consider to be less satisfactory than the original as regards the acoustics"; but St. Andrew's Hall has still to be replaced, and there is talk of a new hall for North London (which badly needs one) at Swiss Cottage. If mistakes have been made it is better that architects should question the principles from which they sprang than that they should persevere with types of design that experience has proved unsatisfactory.

First of all, though, we must try to understand the reasons behind the predilection for reflected sound. Part of it is certainly due to the fact that swooping cantilevered screens and canopies are exciting toys to play with: there is simply more fun to be had out of shapes reminiscent of the Rome railway station than out of the traditional box. But money, as we know, is really the root of all evil. The increased costs of concert promotion have made halls of 1,500 or 2,000 seats uneconomical. The simplest way of increasing the numbers in the box is by putting in a shelf, in other words a balcony, and the deeper the better. To counteract the inevitable muffling effect of a balcony, especially on the seats beneath it, the designers have had recourse to reflecting canopies, which are supposed to push the sound straight to where it is most needed. But as Somerville and Gilford have demonstrated experimentally, and as anyone who has sat at the back of the Festival Hall's "terrace" knows, the intention is not realized in practice—not only is the sound still muffled at the back of the hall, but elsewhere too its character is adversely affected.

Too often the whole matter has been presented as a simple choice between reverberation and clarity. Meeting it in these misleading terms, musicians have in recent years usually opted for the latter. Most serious orchestral music written since the First World War has presupposed an acoustic with a high degree of definition. Mahler still wrote both for and against the highly reverberant concert-halls to which he was accustomed, scoring his tuttis with a fierceness that tends to sound shrill in a typical modern hall, but more recent composers have tended simply to assume that whatever they wrote, however complex harmonically, however detailed in rhythmic articulation, will be audible. Musicians, then, when asked what they wanted reacted against such acoustic monstrosities as Leeds Town Hall, where a single drumbeat can sound like one of Jove's more cloudy utterances, and plumped for clarity.

What they wanted, however, if only they had known it, was not a mere absence of reverberation, which automatically precludes the *blend* of sound that is inherent in the very concept of the classical symphony orchestra, but a satisfactory ratio of direct to reverberant sound, diffused uniformly throughout the hall. But the use of reflectors gets in the way of uniform distribution (even the new Berlin hall is said to have "some lingering echoes", which means, in fact, discrete reflections such as might be expected from the large plain surfaces shown in the photograph), and in addition it leads to a kind of overall hardness of sound. The reverberation of the Festival Hall has been increased since it was first built, but a certain unflattering wiriness still afflicts string-tone there, which may be realistic but would almost certainly not be regarded as ideal by either composers or players.

Somerville and Gilford come down firmly, as we have seen, on the side of the traditional Gewandhaus-type hall as the answer to these problems, nor should there be any insuperable difficulty in reverting to it; even the ornamentation which forms an essential part of it should be capable of reinterpretation in mid-twentieth-century terms, especially on the ceiling, whose elaborately moulded coffers were the basis of good diffusion. One doubt remains, however: that our authors, themselves acoustical engineers rather than musicians, may favour a more reverberant acoustic than some of us would accept for modern or pre-romantic music. Their remark to the effect that "much modern symphonic music, written to produce a strident result, can be performed equally well in an old hall or a modern one" certainly suggests a lack of sympathy with the Stravinskian aesthetic.

But perhaps they provide an answer when they propose, almost jokingly, that if we really want "modern" acoustics, they could be achieved more cheaply by reducing the average volume per seat. Is it beyond the wit of our engineers and architects to devise a hall which follows the basic constructional lines of the old Gewandhaus type, with all its proven advantages, but in which the height of the entire ceiling can be swiftly and silently altered, and with it the crucial volume/seat ratio? Is it entirely fantastic to imagine ourselves listening with pin-drop clarity to Webern's symphony, and returning after the interval to find the same hall made ready for one of Mahler's by the simple expedient of quite literally raising the roof?

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